Chapter 12
Monitoring and Adaptive Management

12.1 Introduction

Monitoring and adaptive management (Figure 12-1) have often been low priorities in our efforts to manage natural resources. Funding, staff availability, and technical issues may make a monitoring program prohibitive for some jurisdictions. In addition, monitoring may also expose what are perceived as failures (Washington State Joint Natural Resources Cabinet 1999).

However, the benefits of a successful monitoring program can be substantial. Many actions taken to protect and manage wetlands have to be considered as experiments because we have not tracked their success in the past. We do not know, or fully understand, all the cause and effect relationships between human actions on the land and the functions performed by wetlands. Thus, we cannot fully predict the outcome of actions taken to protect and manage wetlands.

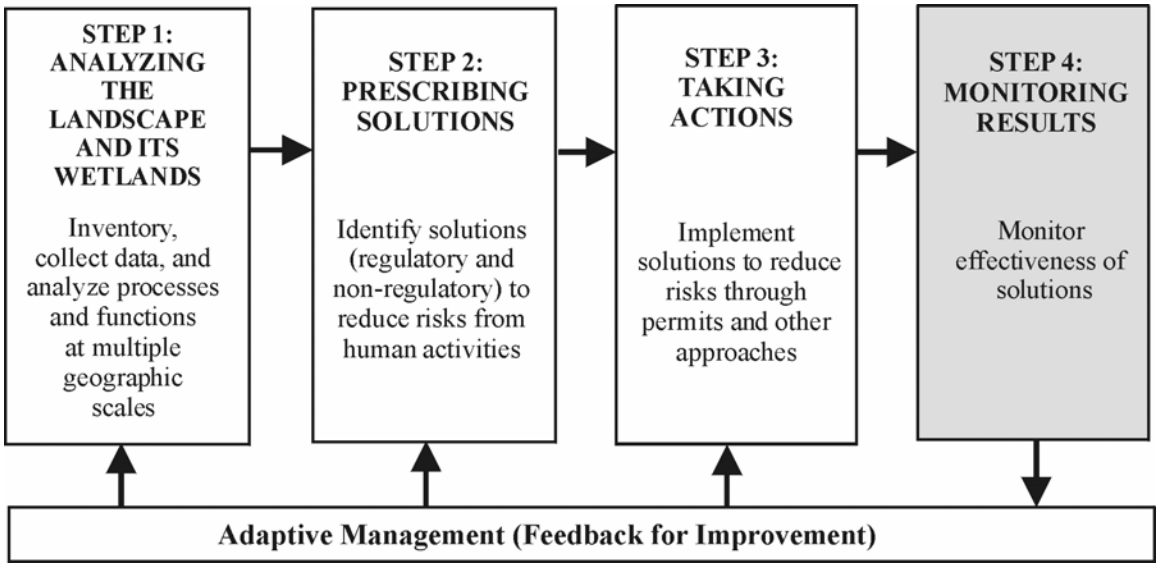

Figure 12-1. Step 4 in the process of protecting and managing wetlands is monitoring (shaded box). Adaptive management (lower box) is a systematic process for continually improving management policies and practices by learning from the outcomes of previous policies and practices.

Monitoring in the context of "adaptive management" is the most efficient way to face this uncertainty. Adaptive management represents a commitment to change approaches for protecting and managing wetlands and to redirect resources as warranted by new

information, even if such change is difficult or unpopular (Washington State Joint Natural Resources Cabinet 1999).

The focus is to monitor the effectiveness of actions taken in Steps 2 and 3 described in previous chapters, and to change the actions as needed. The process is iterative as shown in Figure 12-2. Data collected through monitoring are used to reassess the resource and provide the basis for modifying the solutions and implementation of the program. The goal is to implement a system for modifying past decisions, if needed, that is based on the best available science and that uses new information generated from monitoring the specific actions taken.

A commitment to adaptive management by a local jurisdiction means that there is a willingness to revisit and change past decisions if needed. All aspects of plans, regulations, and other actions should be reconsidered if the monitoring data show there is further loss of wetland functions and values. There is no point in undertaking a program to monitor the resource if there is no willingness to change as a result of new data.

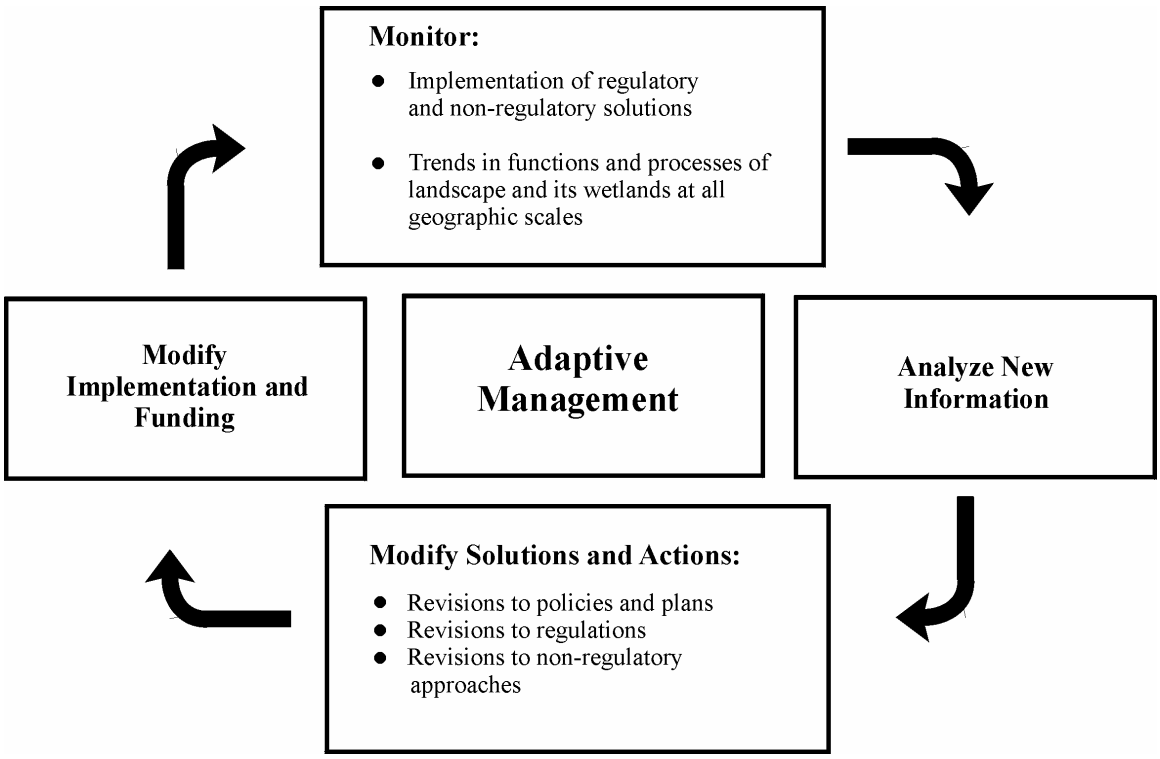

Figure 12-2. Conceptual representation of how wetlands can be protected and managed using adaptive management. Adaptive management implies that the process does not end with the completion of the four steps but keeps cycling.

12.2 What Should Be Monitored?

Monitoring associated with protecting and managing wetlands by local jurisdictions can be divided into three categories, as listed below. All aspects of monitoring are important

in providing feedback to guide decisions for adaptive management. If the functions and values of wetlands are not adequately protected, managers need to know whether this results from inadequate implementation, inadequate standards, or inadequate strategies.

- **Monitoring trends** tracks landscape processes and the wetland resource over time at all geographic scales and records changes in functions and values at individual wetlands. The monitoring should determine if the goals and objectives established for the wetland resource by a local jurisdiction are being met. Monitoring trends is critical in interpreting the effectiveness of efforts to protect and manage wetlands.

- **Monitoring implementation** addresses the extent to which the regulatory and non-regulatory actions proposed in plans and regulations have been taken. This type of monitoring provides a basis for tracking the actions taken and for quality assurance.

- **Monitoring the effectiveness of strategies** addresses how effectively the complete program meets explicit objectives or desired future conditions. This type of monitoring will usually involve working together with other jurisdictions, and it will probably require some assistance from state and federal agencies.

Different strategies are needed to monitor at different geographic scales. In addition, the objectives of a monitoring program may be met in many different ways, not all of which require extensive collection of data. It is not the intent of this chapter to describe the different monitoring strategies and methods that can be used. These will depend on the wetland resources present in a local jurisdiction, the goals and objectives set by that jurisdiction, the solutions they propose, and the actions they take

The following sections outline some of the basic questions that need to be addressed through monitoring for an adaptive program that protects and manages wetlands.

12.2.1 Monitoring Trends in the Resource

The goal of monitoring trends in the wetland resource is to understand if, and how, the landscape processes that control structure and functions within a wetland have changed as a result of changes in land use. The resource needs to be monitored at the contributing landscape scale, the management area scale, and the site scale.

The analysis can be undertaken using the methods and tools discussed in Chapter 5. Regardless of the methods used, however, there is one major question that needs to be addressed through monitoring: *Have land use changes altered landscape processes to the extent that they impact the functions of wetlands in a jurisdiction?* Changes to processes and functions can be either negative, indicating further degradation, or positive, indicating that restoration is succeeding.

This type of monitoring involves identifying:

- Have the major sources of water to the system and flow paths been changed (either degraded or restored)?
- Have the major sources of sediment to the water system changed?
- Have the major sources of nutrients to the system changed?
- Have the major sources of toxic compounds to the system changed?
- Have there been any changes to relatively undisturbed connections between natural habitats?

The objective for monitoring trends at the wetlands themselves is to answer the question: *Have the functions and values of each individual wetland within the jurisdiction changed?*

Continuously monitoring all wetlands, or even a random subset of them, in a jurisdiction is optimal but may not be feasible because of the cost. In the absence of such a program, it is suggested that a local jurisdiction track trends by analyzing the wetland assessments that applicants submit when they propose actions at individual sites. Qualitative trends can be tracked by noting the overall changes in the quality or functions of wetlands being proposed for alteration within each hydrogeomorphic class (depressional, riverine, etc.) or special wetland type (bog, forested, etc.).

Restoration of wetland functions at non-regulatory project sites should also be monitored to determine if the objectives of the projects are being met.

12.2.2 Monitoring Implementation

Monitoring implementation addresses the extent to which the measures proposed for protecting and managing wetlands have been taken as planned. The objective of this task is to determine if the solutions developed in Step 2, Prescribing Solutions, are actually carried out as planned.

12.2.2.1 Monitoring Implementation at the Contributing Landscape Scale

Monitoring the implementation of solutions developed at the scale of the contributing landscape depends on whether the contributing landscape falls entirely within the jurisdiction or if it includes several jurisdictions. In the former case, monitoring the contributing landscape is the same as monitoring the "management area" described below. If the contributing landscape spans several jurisdictions, then the monitoring needed will be based on the objectives of the plans and solutions developed among the jurisdictions.

It is not possible in this document to cover how to monitor all the possible watershed plans, regional plans, partnerships, etc. that can be developed. However, it is important that each objective identified in such plans should have associated with it measures for monitoring its implementation. For example, a watershed plan may have an objective that all jurisdictions in the watershed adopt the same method for rating wetlands to ensure that wetland functions are characterized in the same way throughout the watershed. Monitoring the implementation of this objective involves keeping track of when each jurisdiction adopts the chosen wetland rating system.

12.2.2.2 Monitoring Implementation at the Management Area Scale

Monitoring the implementation of solutions developed at the scale of the management area is a matter of keeping accurate records of the actions taken by the jurisdiction to protect and manage wetlands, and a commitment to compile and analyze the data at specified intervals. The analysis should be based on comparing the actual actions taken against the actions proposed in the original comprehensive plan, critical areas ordinances, shoreline master programs, etc.

For example, a critical areas ordinance may state that each permit for modifications to a wetland requires that the wetland be rated on its functions and values. Monitoring the implementation of this item would require keeping records of how may permits were issued that had the wetlands rated, and how many were issued without the rating.

This type of monitoring should also be applied to non-regulatory programs. For example, if a jurisdiction has a program to acquire conservation easements on lands that it considers important to maintaining landscape processes, it should monitor how many easements have been acquired compared to the total number needed.

Table 12-1 lists some of the common solutions used by jurisdictions in protecting and managing wetlands. Keeping records of these solutions will provide the basis for monitoring the implementation at the scale of the management area.

Table 12-1. Monitoring common planning, regulatory, and non-regulatory solutions to protecting and managing wetlands.

Action	What to Monitor
Zoning	Number of zoning variances permitted
Development standards for areas sensitive to disturbance	Number of variances permitted
Setbacks to protect resource	Number of variances permitted Number of violations
Preservation of important wetlands	Number of acres with conservation easements or fee title
Conservation of wetland resources	Number of acres enrolled in Current Use Taxation program or other applicable programs
Voluntary restoration of wetlands	Number of acres successfully restored

12.2.2.3 Monitoring Implementation at the Site Scale

Monitoring the implementation of solutions developed at the site scale is a matter of keeping accurate records of the permits approved and other actions taken at individual sites. This includes, for example, monitoring the success of actions taken to restore wetlands, enforcement actions, follow-up site visits, and compliance with permit conditions. The review of the scientific information presented in Volume 1, Chapter 6, highlighted the fact that many projects that compensate for impacts to wetlands are not successful because there has been no follow-up. Therefore, follow-up for compensatory mitigation projects is very important.

12.3 What is Adaptive Management?

Adaptive management has been defined in various ways since its development in the early 1970s. Different people and organizations continue to have somewhat differing views of the best definition for their purposes. In order to bring some consistency and clarity, the following working definition for this concept is used in this chapter:

> *Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of previous policies and practices.*

The goal of adaptive management, in the context of managing wetlands by local jurisdictions, is to implement a system for making decisions that is guided by the best available science and that uses new information generated from the monitoring of the resource. The process is iterative as shown in Figure 12-2. Monitoring results in new data that provide the basis for revising past decisions, and these revised decisions are then monitored.

Adaptive management is based on the assumption that managed ecosystems are complex and inherently unpredictable. The approach admits that, at present, humans do not know enough to manage ecosystems. Adaptive management, from this perspective, treats management policies and practices as experiments that assess the responses of an ecosystem as human behavior changes (Lee 1999). The goal is to learn and change objectives as needed. However, this approach has often not been considered the mark of a good manager, who is rewarded instead for steadfast pursuit of objectives (Lee 1999).

Since a program of adaptive management is linked to the monitoring of the resource and the implementation of plans, it is not possible in this report to outline specifically what such a program should entail. The details will depend on the solutions for protecting and managing wetlands that are proposed by each jurisdiction. The important point to stress is that adaptive management will only work if there is a willingness to monitor and then actually change polices and practices.

Some of the characteristics of adaptive management are:

- Acknowledgement that there is still much uncertainty about what policy or practice is best for the particular issue related to protecting and managing wetlands;
- Careful implementation of a plan of action designed to reveal the knowledge that is currently lacking;
- Monitoring of both the resource and the implementation of plans and practices;
- Analysis of the outcomes of policies and practices in terms of the original objectives; and
- Incorporation of the results into future decisions.

A brief history and additional resources for adaptive management

The text below is adapted from the University of Oregon (http://oregonstate.edu/instruction/anth481/ectop/ecadm.html).

C.S. Holling and several colleagues developed the concept of adaptive management at the University of British Columbia's Institute of Resource Ecology in the late 1960s. Adaptive management reached the scientific literature in Holling's book, *Resilience and Stability of Ecological Systems*, published in 1978. The emphasis of the Holling approach is to experiment to learn the boundaries of natural systems. Holling and his colleagues worked with resource managers in British Columbia on a number of management experiments and public participation workshops, testing the process.

Adaptive management became an important concept in resource management in the United States when K.N. Lee introduced it to the Northwest Power Planning Council in 1984. Lee learned about adaptive management from Randall Peterman, who in February 1984 gave a talk about experimental management. Subsequently, different forms of adaptive management have become part of the Northwest Forest Plan, the Oregon Plan for Salmon and Watersheds, the Oregon Department of Forestry Plan to manage state forests, and many other processes for resource planning.

For additional information on adaptive management, see:

Holling C.S. 1978. *Adaptive Environmental Assessment and Management.* John Wiley & Sons.

Walters, C. 1986. *Adaptive Resource Management*. The Free Press.

Lee, K.N. 1993. *Compass and Gyroscope*. Island Press.

Lee, K.N. 1999. Appraising adaptive management. *Conservation Ecology* 3(2): 3. Available at: http://www.consecol.org/vol3/iss2/art3

Adaptive Management Practitioners' Network: http://www.iatp.org/AEAM/index.html

The Adaptive Management Network creates and supports learning and mentoring opportunities for practitioners linking science and collaboration to address critical, practical, and complex ecological and institutional challenges.